EXAMPLE 16 BI-AXIAL BENDING

FALSEWORK BEAM CANTED 2% OR LESS

Span = 48 Ft
Cross slope = 2%

Member W 14 x 176
I_{XX} = 2140 In^4 I_{YY} = 838 In^4
d = 15.22 In b_f = 15.65 In

Uniform Load P:
Total Section:
Load A = Concrete (160 Lb/Ft^3) + Beam (176 Lb/Ft) + LL
= 1420 Lb/Ft
Load B = Concrete only (150 Lb/Ft^3) = 1000 Lb/Ft
Bottom slab and stems:
Load C = Concrete (150 Lb/Ft^3) = 649 Lb/Ft

Assume lateral bracing is adequate so that F_b = 22,000 psi maximum of the Standard Specifications is not exceeded.

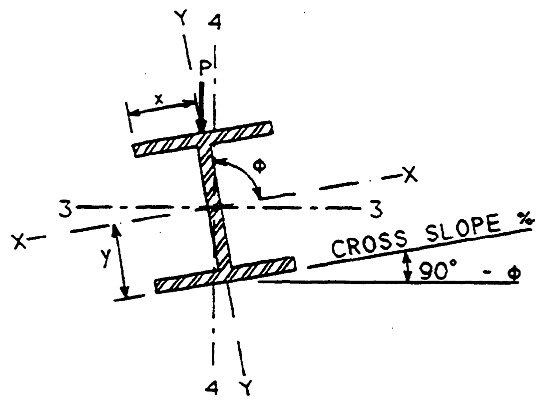

FIGURE 1

$$\phi = 90° - \tan^{-1}(\text{cross slope})$$

$$= 90° - \tan^{-1}\left(\frac{2.00}{100}\right) = 88.85°$$

$$y = \frac{d}{2} = \frac{15.22 \text{ Inches}}{2} = 7.61 \text{ Inches}$$

$$x = \frac{b_f}{2} = \frac{15.65 \text{ Inches}}{2} = 7.83 \text{ Inches}$$

a) Check bending using Load A:

$$M = \frac{WL^2}{8} = \frac{1420 \text{ Lb/Ft}(48 \text{ Ft})^2}{8} = 408{,}960 \text{ Ft-Lbs} = 4{,}907{,}520 \text{ In-Lbs}$$

$$f_b = 4{,}907{,}520\left(\frac{7.61}{2140}\sin 88.85° + \frac{7.83}{838}\cos 88.85°\right) = 18{,}368 \text{ psi}$$

18,368 psi < 22,000 psi allowable

b) Check deflection about the 3-3 axis, using Load B:

$$\Delta = \frac{5WL^4}{384EI_3} = \frac{5(1000 \text{ Lb/Ft})(48 \text{ Ft})^4(1728 \text{ In}^3/\text{Ft}^3)}{384(30 \times 10^6 \text{ psi})(I_{XX}\sin^2\phi + I_{YY}\cos^2\phi)}$$

$$= \frac{5(1000)(48)^4(1728)}{384(30 \times 10^6)(2140 \sin^2 88.85 + 838 \cos^2 88.85)}$$

$$= 1.86 \text{ In.} < \frac{L}{240} = \frac{(48)(12)}{240} = 2.40 \text{ Inches allowable}$$

FALSEWORK BEAM CANTED MORE THAN 2%

Span = 48 Ft
Cross slope = 10%

Member W 14 x 176
I_{XX} = 2140 In^4 I_{YY} = 838 In^4
d = 15.22 In b_f = 15.65 In

Uniform Load P:
Total Section:
Load A = Concrete (160 Lb/Ft^3) + Beam (176 Lb/Ft) + LL
= 1420 Lb/Ft
Load B = Concrete only (150 Lb/Ft^3) = 1000 Lb/Ft
Bottom slab and stems:
Load C = Concrete (150 Lb/Ft^3) = 649 Lb/Ft

Assume lateral bracing is adequate so that F_b = 22,000 psi maximum of the Standard Specifications is not exceeded.

$$\phi = 90° - \tan^{-1}\frac{10}{100} = 84.29°$$

a) Check bending:

$$M = \frac{WL^2}{8} = \frac{(1420\ Lb/Ft)(48\ Ft)^2}{8} = 408{,}960\ Ft\text{-}Lbs = 4{,}907{,}520\ In\text{-}Lbs$$

$$f_b = 4{,}907{,}520\left(\frac{7.61}{2140}\sin 84.29° + \frac{7.83}{838}\cos 84.29°\right)$$

= 21,927 psi < 22,000 psi allowable

b) Check deflections:

Check y and x deflections versus L/240 using Load B:

Load in the y-direction = 1000(cos(90-84.29)) = 995.04 Lb/FT

$$\Delta_y = \frac{5WL^4}{384EI} = \frac{5(995.04\ Lb/Ft)(48\ Ft)^4(1728\ In^3/Ft^3)}{384(30 \times 10^6\ psi)(2140\ In^4)}$$

$$= 1.85\ In. < \frac{L}{240} = \frac{(48)(12)}{240} = 2.40\ \text{Inches allowable}$$

Load in the x-direction = 1000(sin(90-84.29)) = 99.49 Lb/FT

$$\Delta_x = \frac{5WL^4}{384EI} = \frac{5(99.49\ Lb/Ft)(48\ Ft)^4(1728\ In^3/Ft^3)}{384(30 \times 10^6\ psi)(838\ In^4)}$$

$$= 0.47\ In. < \frac{L}{240} = \frac{(48)(12)}{240} = 2.4\ \text{Inches allowable}$$

Check Δ_x versus max allowable of 1.5 inches using Load C:

Load in the x-direction = 649(sin(90-84.29)) = 64.57 Lb/FT

$$\Delta_x = \frac{5WL^4}{384EI} = \frac{5(64.57\ \text{Lb/Ft})(48\ \text{Ft})^4(1728\ \text{In}^3/\text{Ft}^3)}{384(30 \times 10^6\ \text{psi})(838\ \text{In}^4)}$$

$= 0.31$ In.

Load in the y-direction = 649(cos(90-84.29)) = 645.78 Lb/FT

$$\Delta_y = \frac{5WL^4}{384EI} = \frac{5(645.78\ \text{Lb/Ft})(48\ \text{Ft})^4(1728\ \text{In}^3/\text{Ft}^3)}{384(30 \times 10^6\ \text{psi})(2140\ \text{In}^4)}$$

$= 1.20$ In.

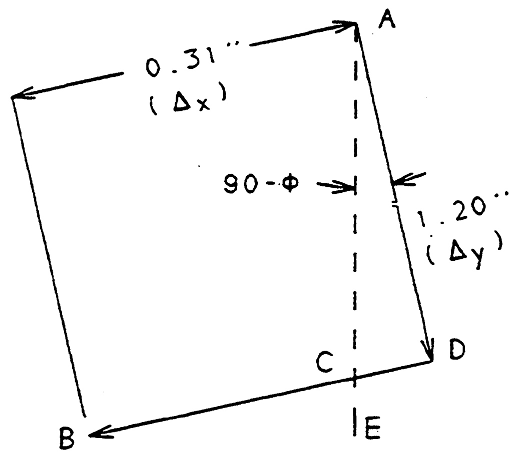

FIGURE 2

Lateral deviation = BC.

CD = AD[tan(90° - ϕ)] = 0.12 In.

BC = BD - CD

= 0.31 - 0.12 = 0.19 < 1.5 In.